C-2.6 Explain the concept of half-life, its use in determining the age of materials, and its significance to nuclear waste disposal.

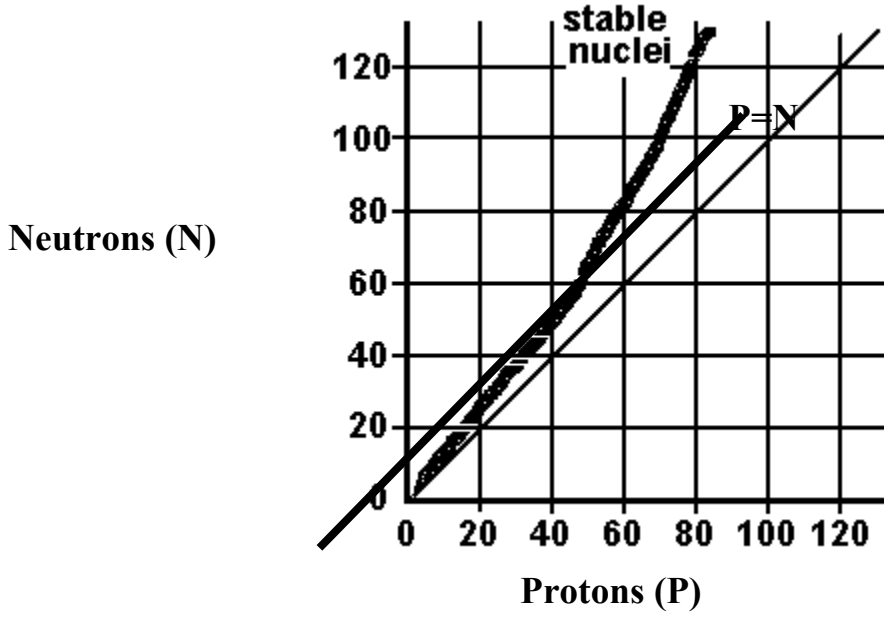
Revised Taxonomy Levels 2.7 B Explain conceptual knowledge

Key concepts

This topic was not addressed in physical science

It is essential for students to

- Understand that only certain combinations of protons and neutrons seem to be stable (see stability curve graph). Any isotope of any element that does not lie in the stability band with a stable neutron/proton ratio is likely to be radioactive.



  - There are no stable nuclei with an atomic number higher than 83 or a neutron number higher than 126.
  - The more protons in the nuclei, the more neutrons are needed for stability.
    - The stability band pulls away from the P=N line.
  - Stability is favored by even numbers of protons and even numbers of neutrons.
- Understand that radioactivity results from the random and spontaneous breakdown of the unstable nucleus of an atom. This breakdown is called radioactive decay of the unstable atom/nucleus/radioisotope.
  - In the breakdown of the unstable nucleus, energy is released by the emission of alpha, beta and gamma ionizing radiation.
  - The breakdown of an unstable atom is referred to as decay or disintegration and is a random process meaning it is a matter of chance which particular nucleus decays.
- Understand that not all of the atoms of a radioisotope decay at the same time, but they decay at a rate that is characteristic to the isotope. The rate of decay is a fixed rate called a half-life.
  - The half-life of a radioisotope describes how long it takes for half of the atoms in a given mass to decay.

- Some isotopes decay very rapidly and, therefore, have a high specific activity. Others decay at a much slower rate.

❖ Understand carbon dating
- As soon as a living organism dies, it stops taking in new carbon.
- The ratio of carbon-12 to carbon-14 at the moment of death is the same as every other living thing, but the carbon-14 decays and is not replaced.
- The carbon-14 decays with its half-life of 5,700 years, while the amount of carbon-12 remains constant in the sample.
- By looking at the ratio of carbon-12 to carbon-14 in the sample and comparing it to the ratio in a living organism, it is possible to determine the age of a formerly living thing fairly precisely.

❖ Understand how the half life of nuclear waste determines how it is processed and stored.

Assessment

The verb, explain means that the major focus of assessment should be for students to "construct a cause and effect model". In this case, assessments will ensure that students can model how the half life of a radioactive element determines its effect on the environment. Because the indicator is written as conceptual knowledge, assessments should require that students understand the "interrelationships among the basic elements within a larger structure that enable them to function together." In this case, assessments must show that students can construct a cause and effect statement relating how the nuclear structure of the atom determines its stability, and the process and consequences of the decay of unstable elements.